Real-time DII COE Enables Real-time Technologies

http://www.dii-af.hanscom.af.mil/infrastructure/COE/rtipt/rtipt_hm.htm

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Outline

- EAF C2 Architecture
- C2 Weapon System Spectrum
- Data Criticality - Real-time Needed?
- RT DII COE Accomplishments

EAF C2 Architecture

EAF Key Elements - People, Processes and Systems

C2 Weapon System Spectrum

Air Mission Example

Deliberate Planning

Crisis Action Planning

JFACC Combat Plan; Intel Briefs

ATO Generation & Distro

Mission Planning

Mission Pre-brief;

Mission Execution

What C2 Weapon Systems:

-Perform These Functions?

-Contribute Data for These Functions?

Are Functions Performed in < 5 Minutes, With Accuracy, With Guarantee?

T-18 months

T-7 days?

T-24 hours

Complete @ T-12 hours

T-0 hours

T+1 hour

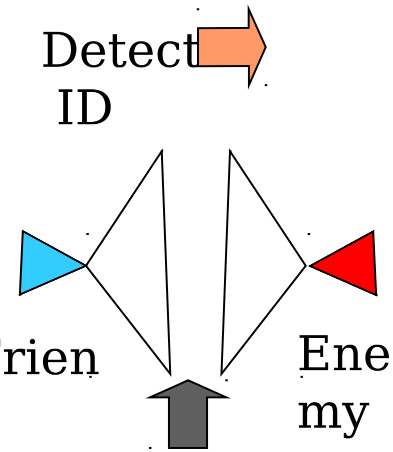
C2 Weapon System Spectrum

Air Mission Example

Mission Execution: A-A, A-G, SEAD

<u>Surveillance Area</u>

Detect ID

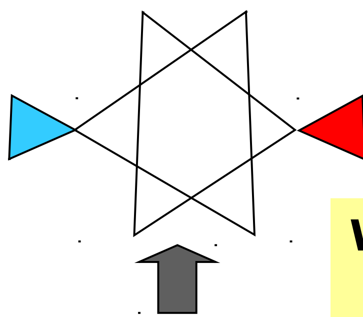


Friend

Enemy

Outside Weapon Parameters

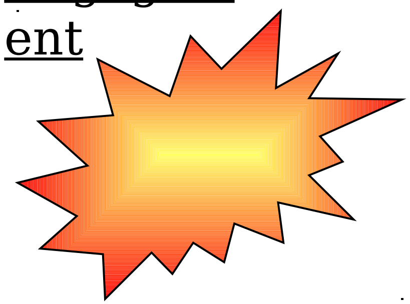
<u>Weapons Engagement Zone</u>



Within Weapon Parameters

<u>Commit</u>

<u>Engagement</u>



What C2 Weapon Systems:
-Perform These Functions?
-Contribute Data for These Functio
Are Functions Performed in < 5 Minutes, With Accuracy, With Guarantee?

T- Seconds

T- Seconds

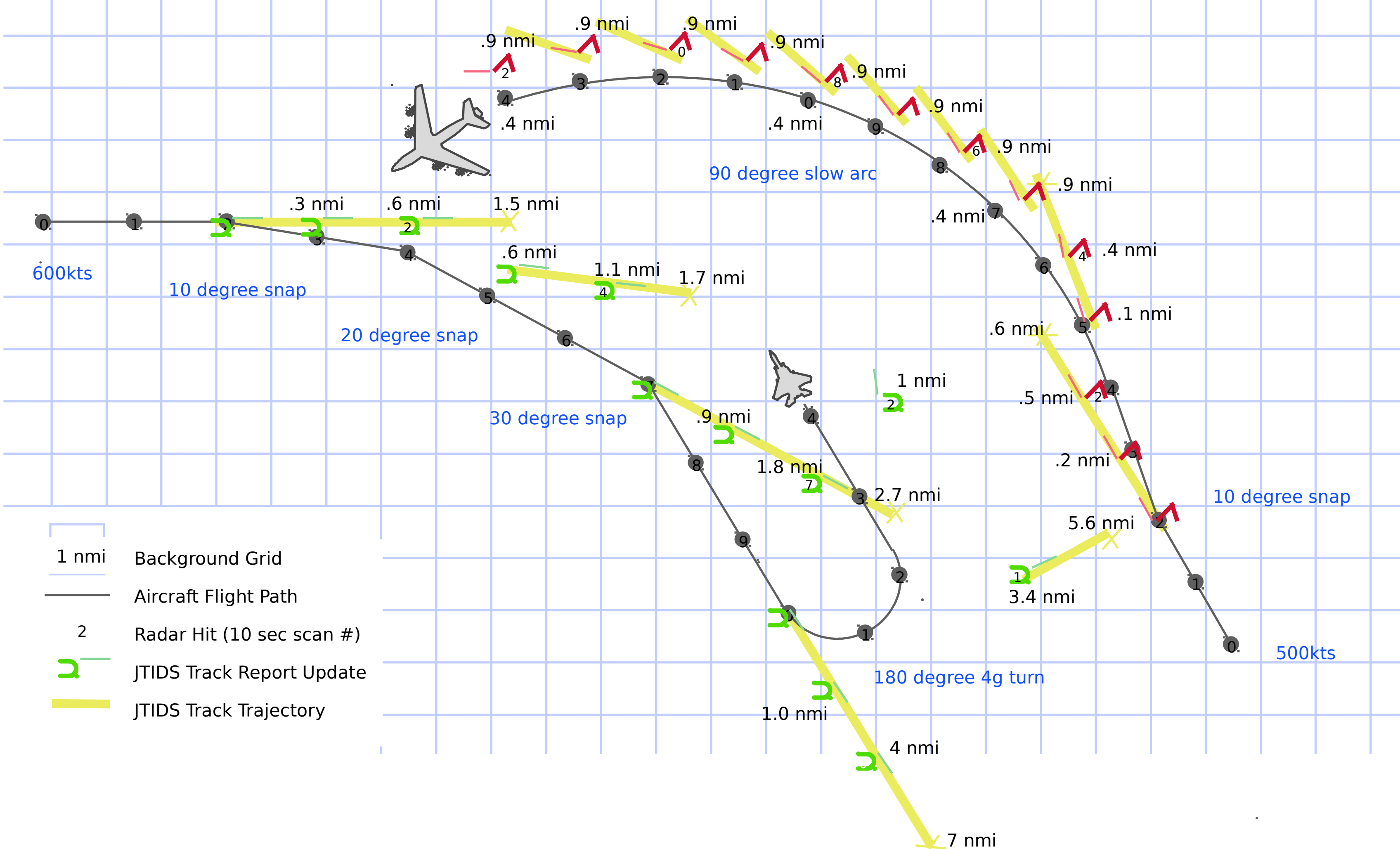
T- Seconds

T - 0

Key Factors: Accuracy of Time Stamp <u>&</u> Data ; NO Stale D

Is the Data You Are Providing Time Critical? Impacts of Delay: 20-30 Sec Data Latency

With perfect tracking (i.e., position/heading/speed reset to true each radar scan)
With perfect reporting and reception (i.e., updates received every 10 sec)



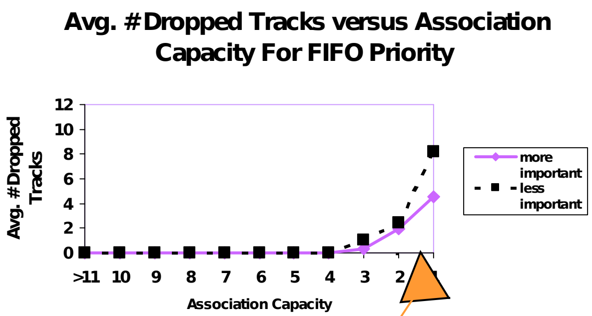
When Do You Know You *Need* Real-time (RT)?

- **Game of Deadlines**
  - **Rule of Thumb: RT = Milliseconds --> 5 Minutes**
  - **What # Deadlines Feed the 'Decision Process'?**
    - **C2 Data Flow (Human) & C2 System Processing (Automated)**
  - **Is Deadline Guarantee Important?**
    - **What # of Misses Can Be Tolerated?**
    - **What are the Consequences of One (or More) Misses?**
  - **What Timeframe for Next Update?**
- **Some Sources of Deadline Misses:**
  - **Method of On-Board Data Processing**
  - **Choice of Priority Scheduling Policy**
    - **FIFO, Fixed, Dynamic**

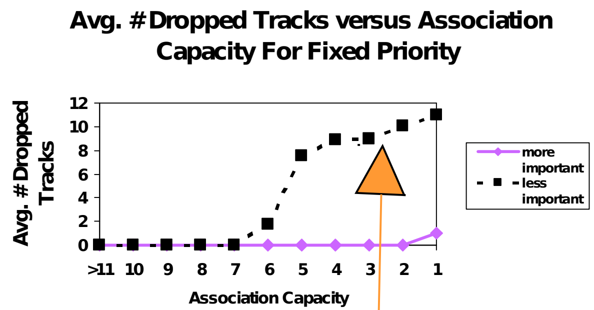
Design Considerations That Impact RT Data

Differences in FIFO, Fixed, and Dynamic Priority Scheduling

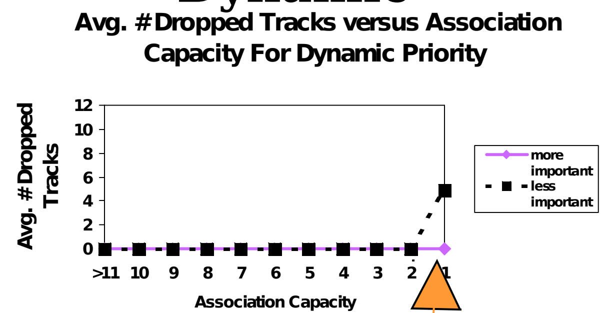
FIFO



Fixed



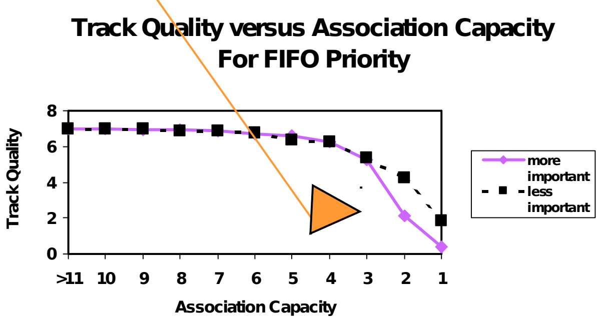
Dynamic

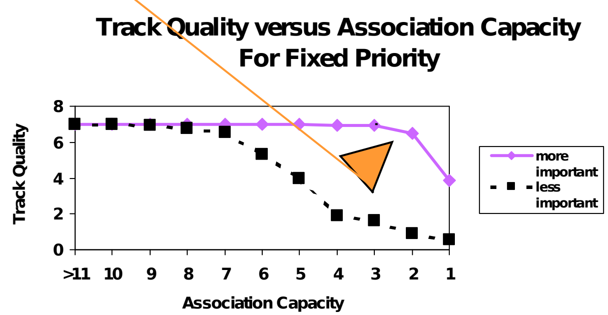


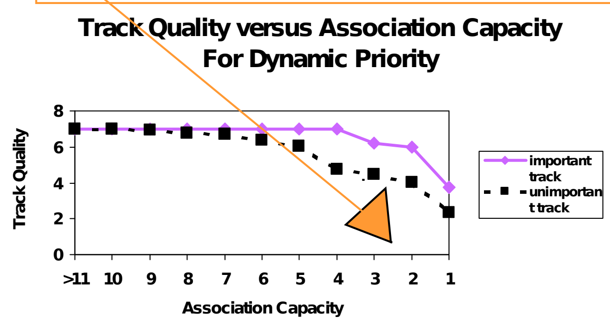
High Priority Tracks Got Dropped and have Bad TQ

Drop *Low Priority* Tracks to Get Better TQ on *High Priority* Tracks

No *High Priority* Tracks Dropped. Overall Better TQ







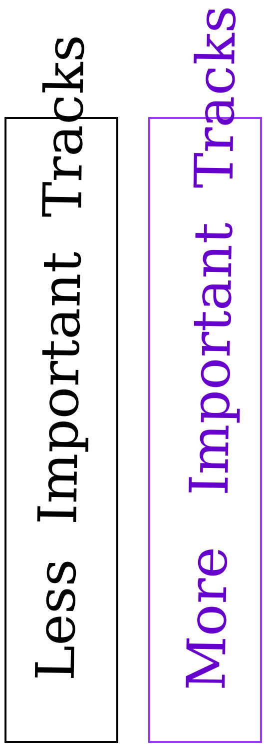
Key:
Track Quality: 0-7 (7 = Ideal
Association Capacity = # Tr
Processed under Constraint

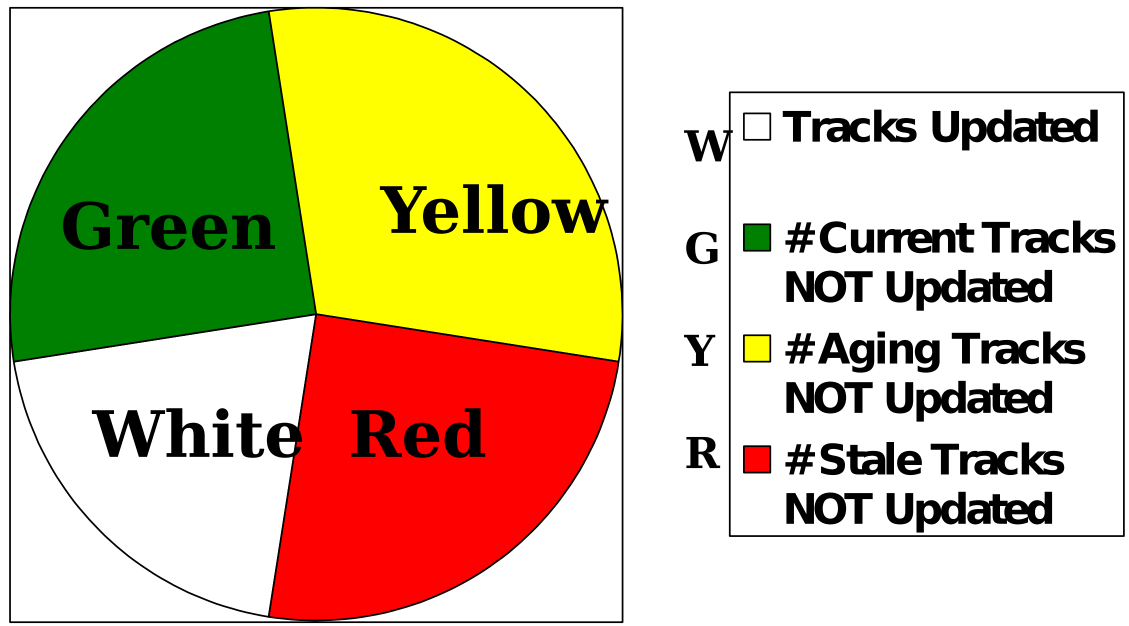
FIFO: TBMCS

FIXED: AWACS, JSTARS, R/SAOC, CM

Demonstration Display

Screen Explanation

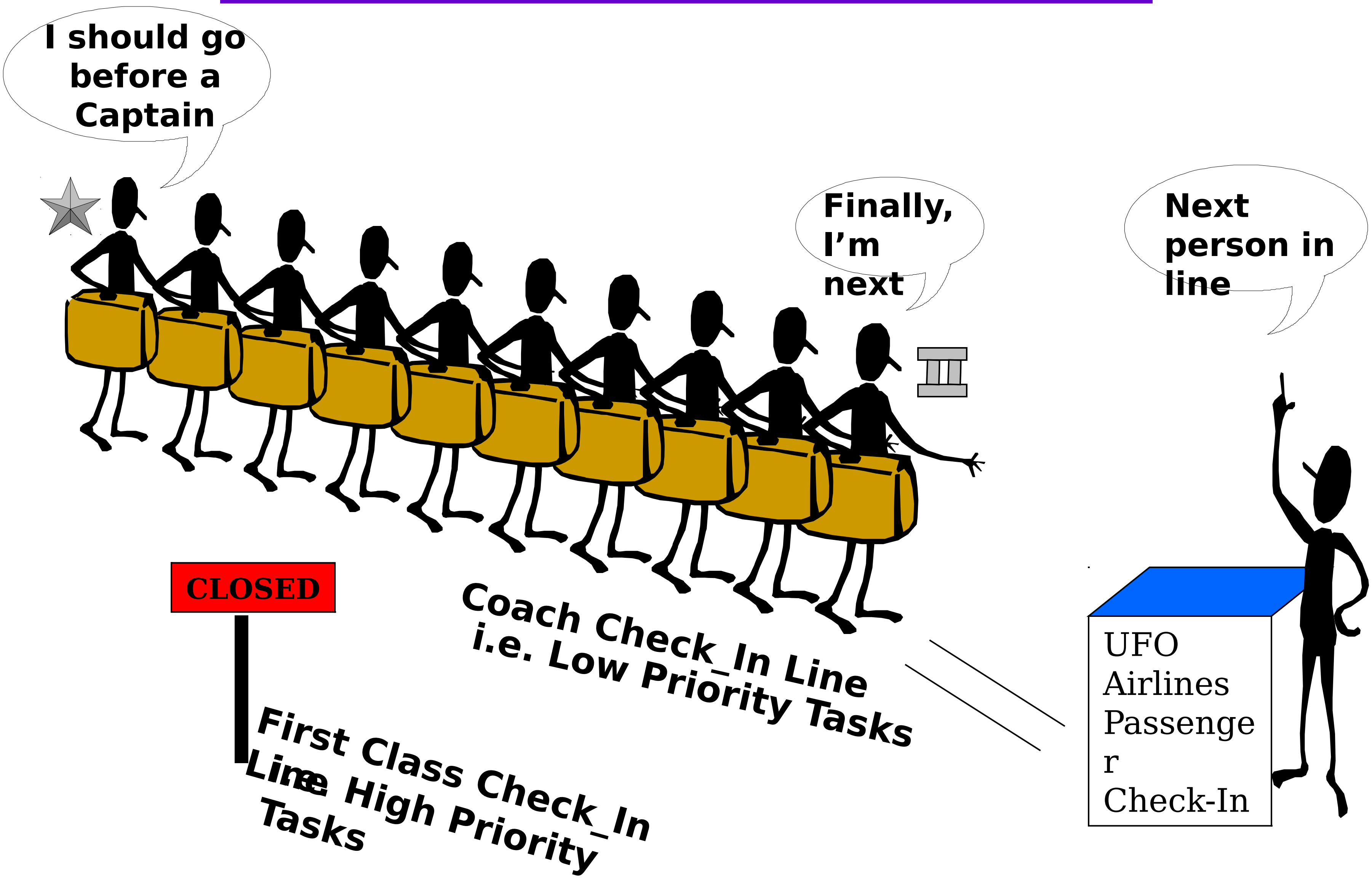




Quality of Track Estimate (Perfect Track = 7)

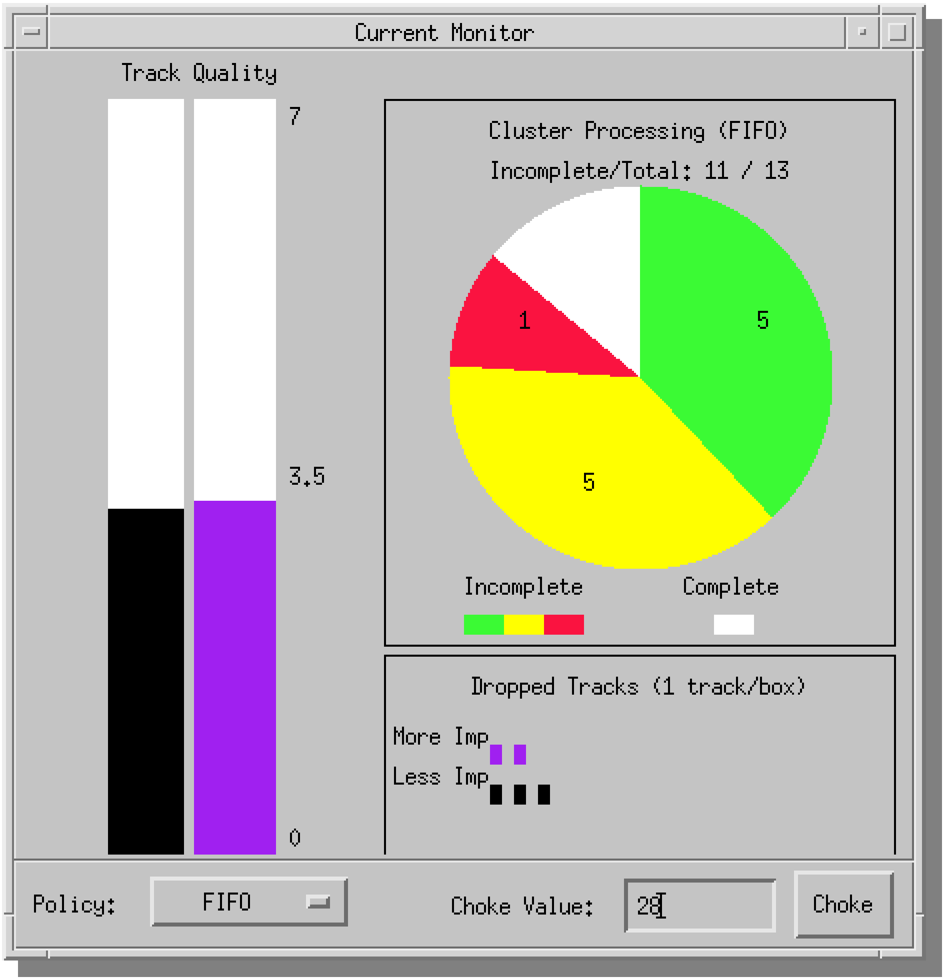
Confidence in <u>All</u> Tracks NOT Updated

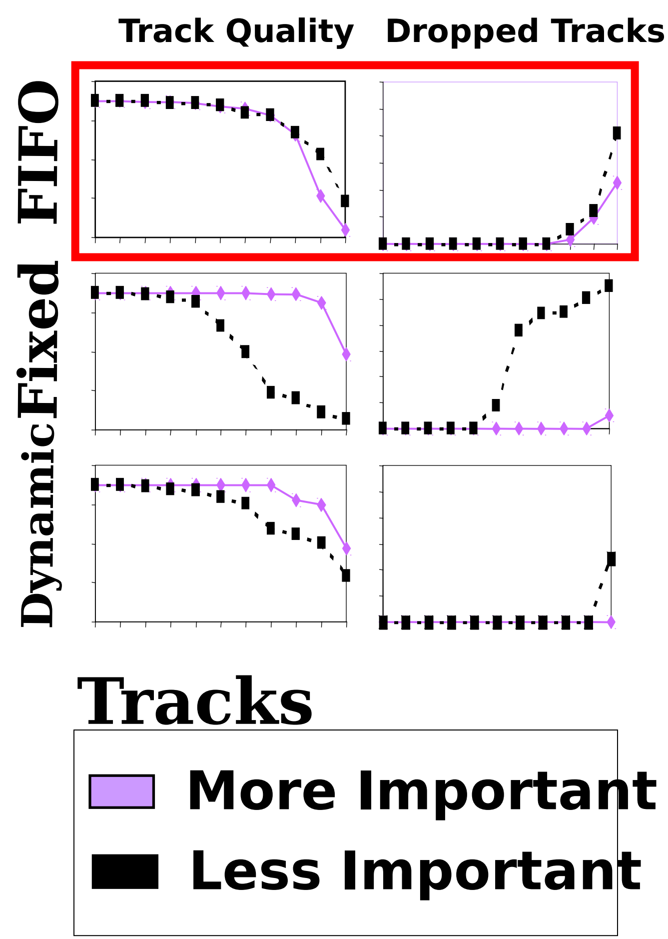
First-In / First-Out Scheduling



Typical Display and Results:

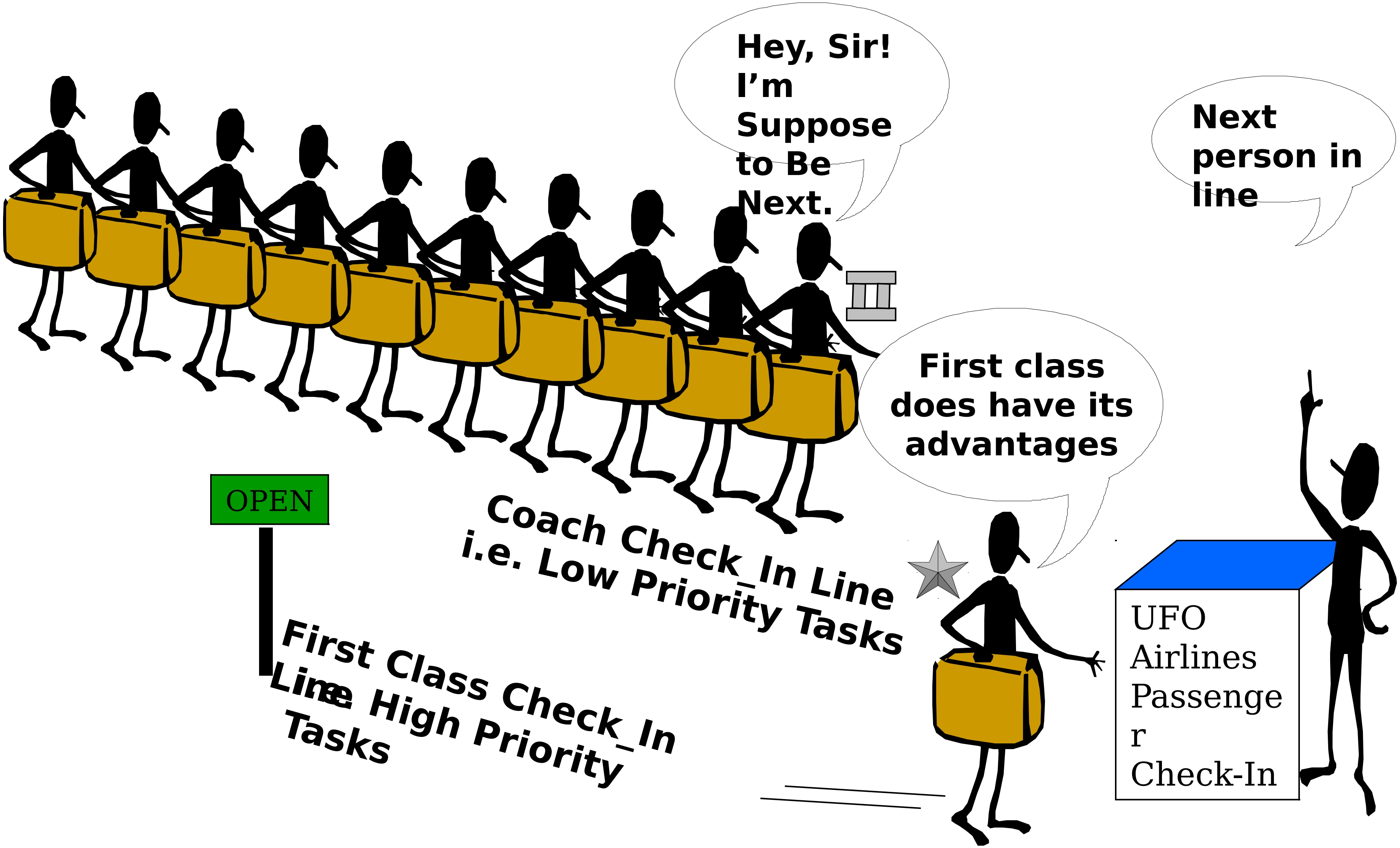
FIFO Scheduling





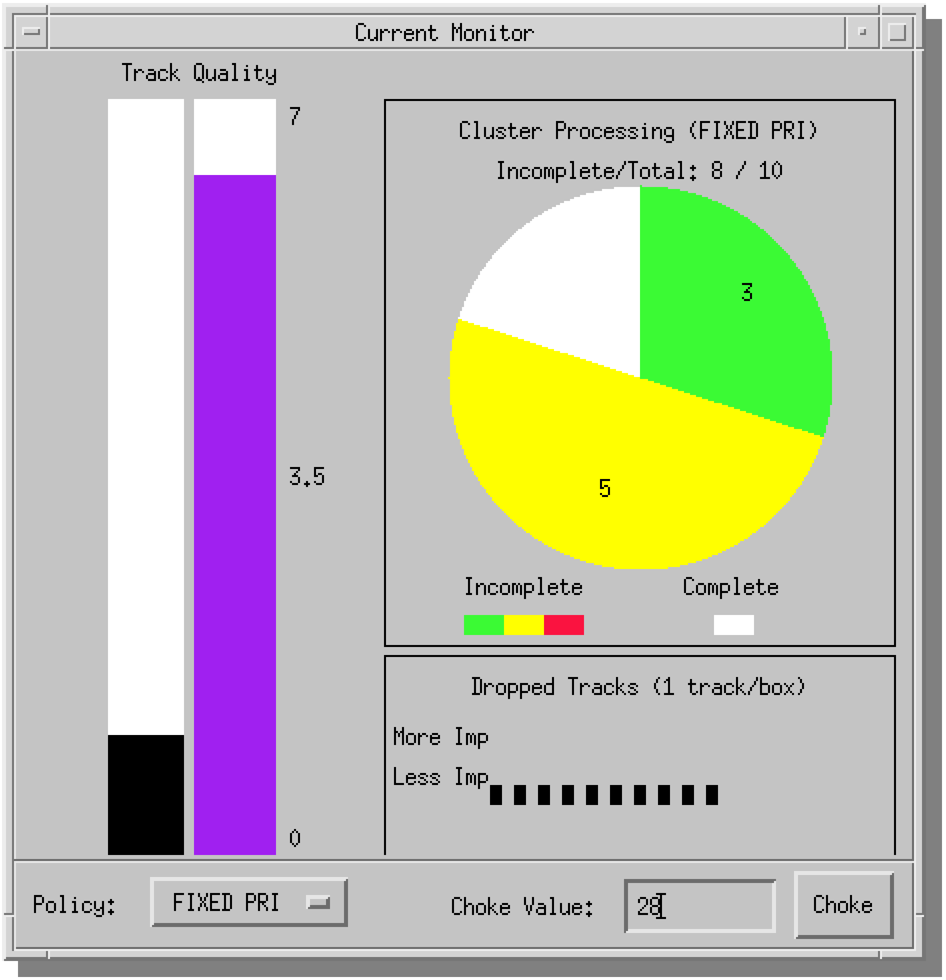
High Priority **Tracks Got Dropped--Increased Operator Work**

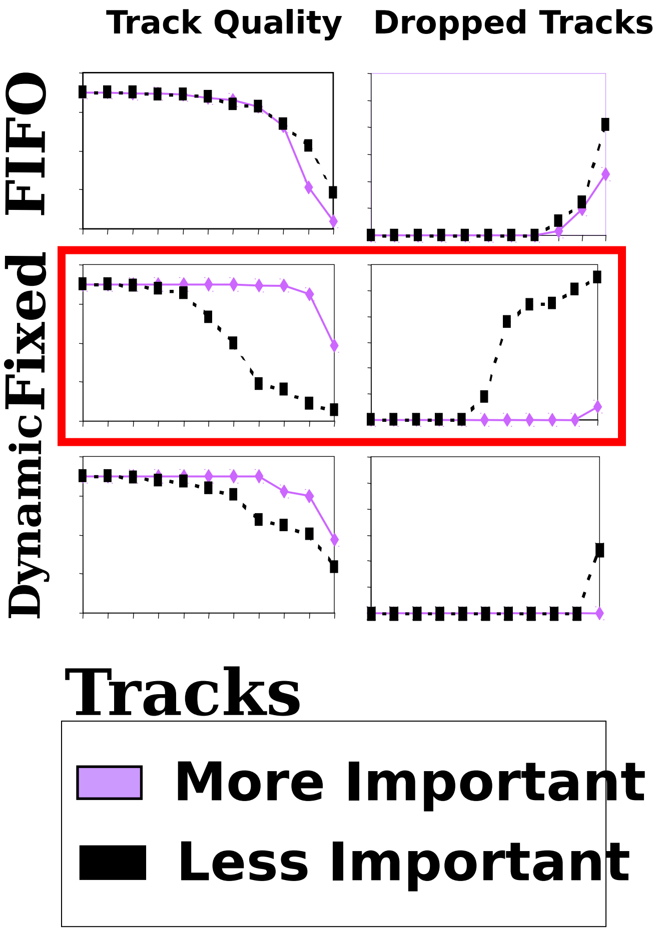
Fixed Priority Scheduling



Typical Display and Results:

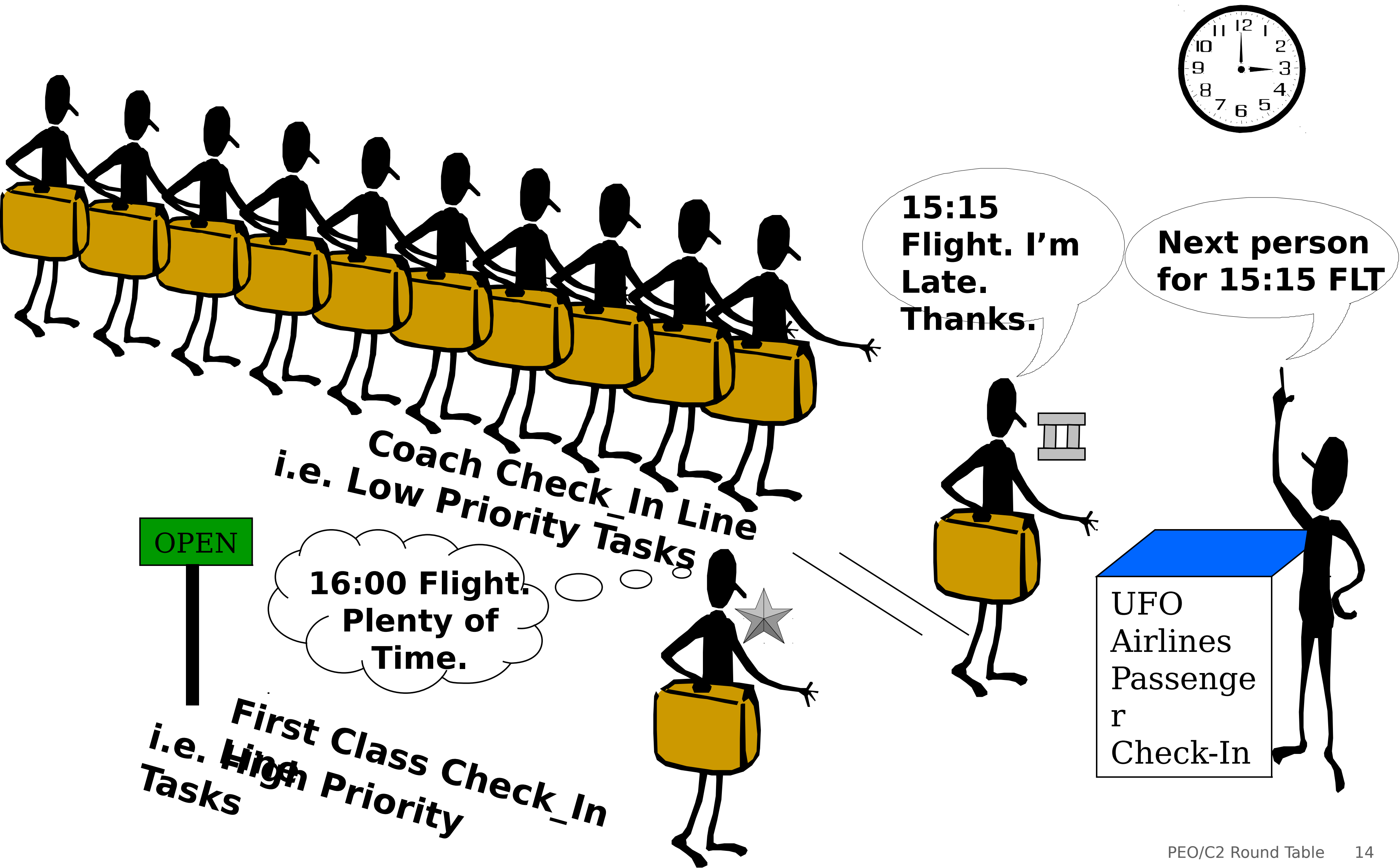
Fixed Priority Scheduling



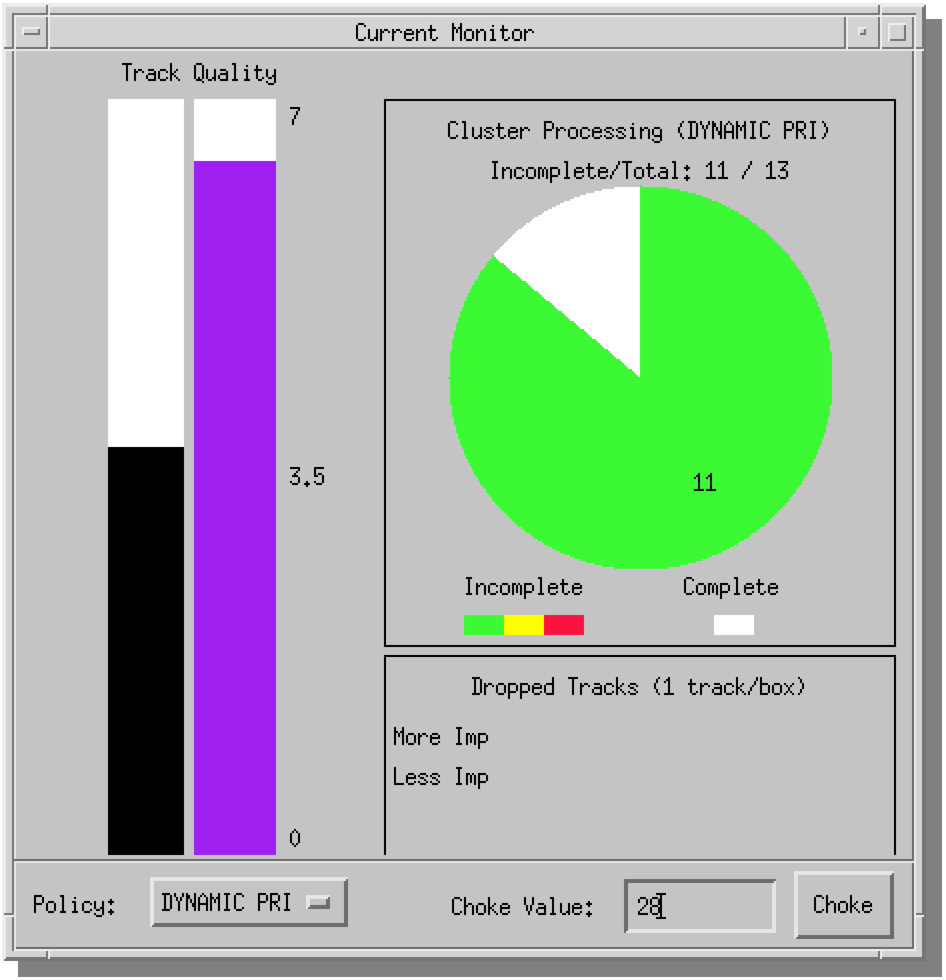


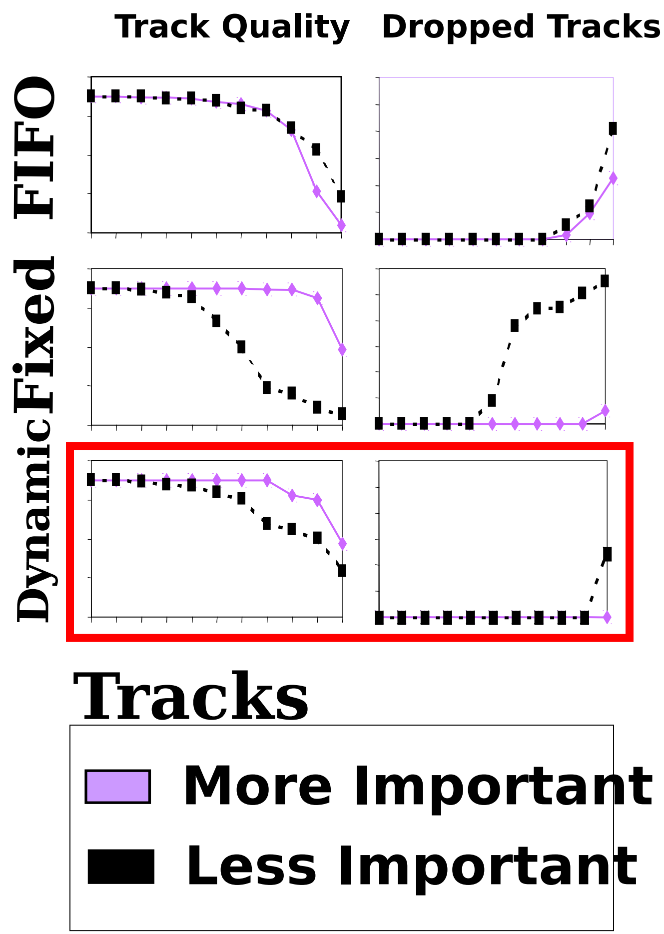
High Priority **Tracks Got Processed--BUT Decreased Situation**

Dynamic Priority Scheduling



Results: Dynamic Priority Scheduling





No Tracks Got Dropped -- Operator Workload O

Which Scheduling Choice Today?

- Hurdles to Dynamic Priority Approach
  - Research Project! Engineering Theory Since 1973
- Fixed Priority Approach Can Be Better for Real-time
  - Detailed Analysis Required -- Its Tough!
    - Ad Hoc Approach Typical: "Always Done That Way"
  - Real-time Scheduling Disciplines Required
    - Understand Timing Behavior of Applications
    - Preserve Correct & Consistent Data
- FIFO is DII COE Approach
  - Not Good Enough for Most C2 Systems

Make Fixed Priority Scheduling a DII COE Optio

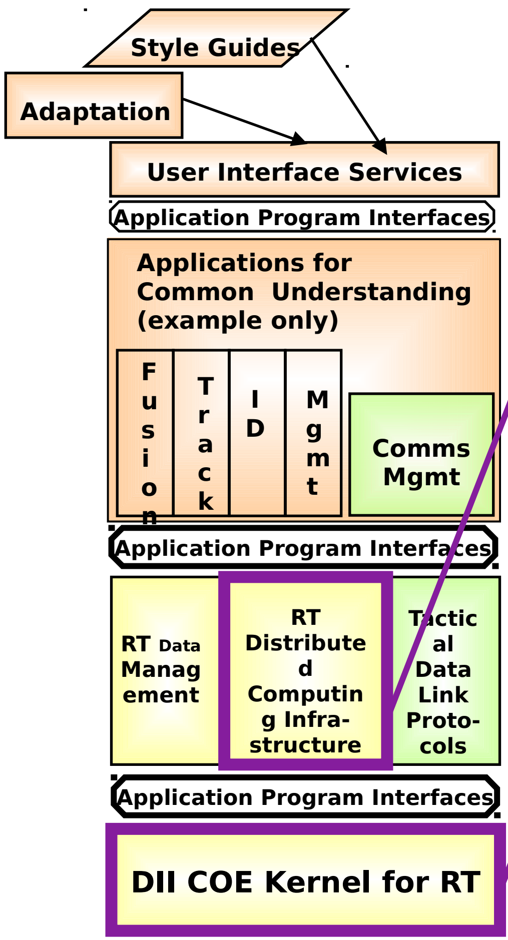
Relevance to RT DII COE Activities

- **Demo Showed Improvement in Mission Performance Using Real-time Technologies**
  - **Theoretical Basis for Improving on “The Way We’ve Always Done It”**
- **RT DII COE Provides the Real-time Foundation To Implement Real-time Technologies**
  - **RTOS and RT Infrastructure Supports:**
    - **Predictable Timelines, Priority, and RT Scheduling**
  - **Configurable RT Kernel**
    - **Make Dissemination of Future RT DII COE Segments Easier**

RT DII COE is the <u>Enabler</u> for RT Approaches

RT DII COE Accomplishments

Technology That Enables Dynamic Scheduling



RT Common Object Request Broker (RT CORBA) for Distributed Computing

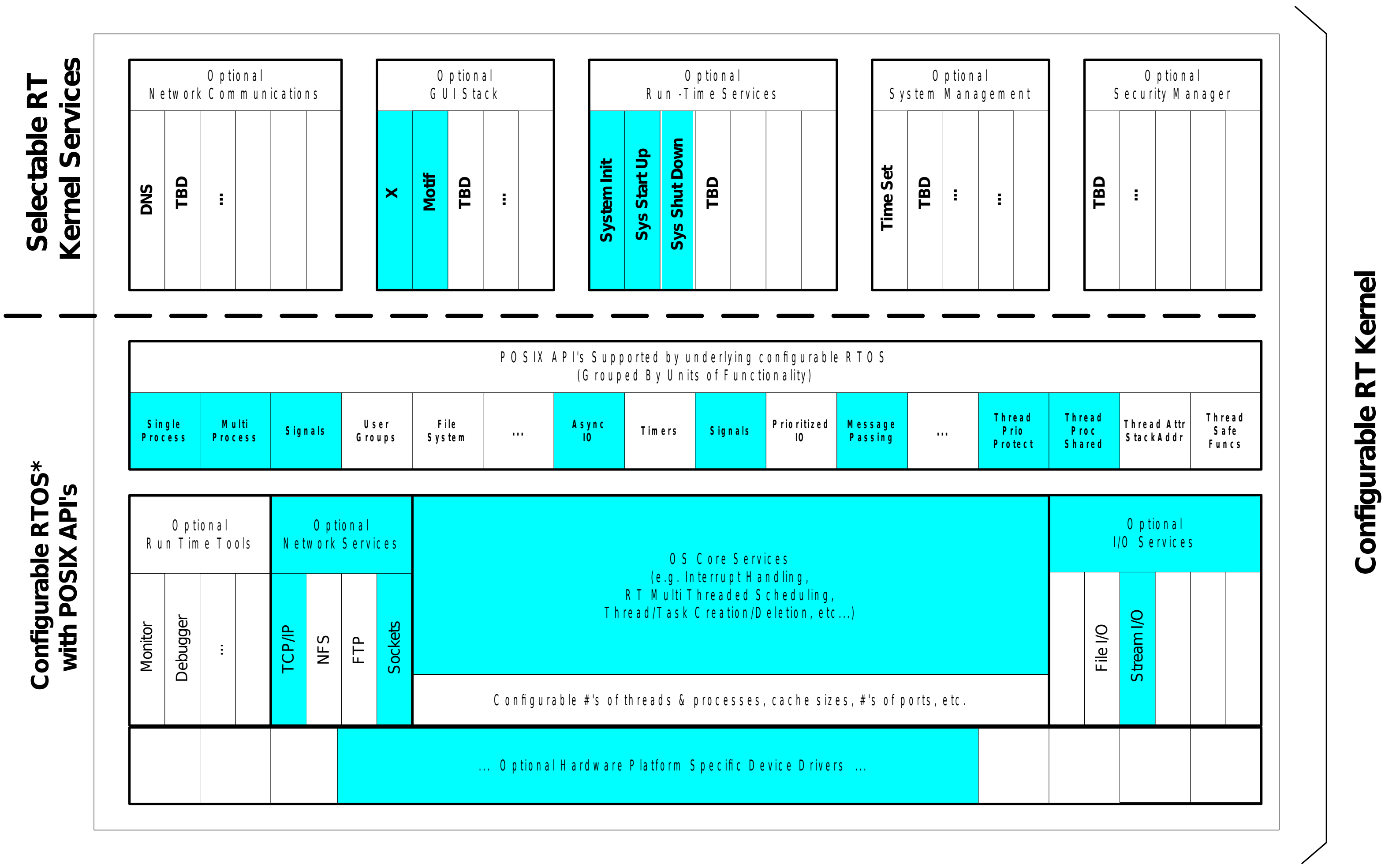
- **Lockheed Martin's HARDPack as candidate initial product**
  - **HARDPack 1.3 or later**
    - **RT extensions**
    - **IIOP interface to nonRT orbs**
    - **Available for LynxOS, Solaris**

Configurable DII COE RT Kernel

- **POSIX APIs for Real-time OS**
  - **LynxOS in reference implementation**
- **RT appropriate capabilities**
- **Selectable Kernel Services**
  - **Not monolithic kernel**
- **Configuration from RTOS up**
- **RT "Stickers" for mixing, matching applications to OS,**

Will be in DISA Release 5.0, October 2000

RT DII COE Accomplishments
Configurable RT DII COE Kernel

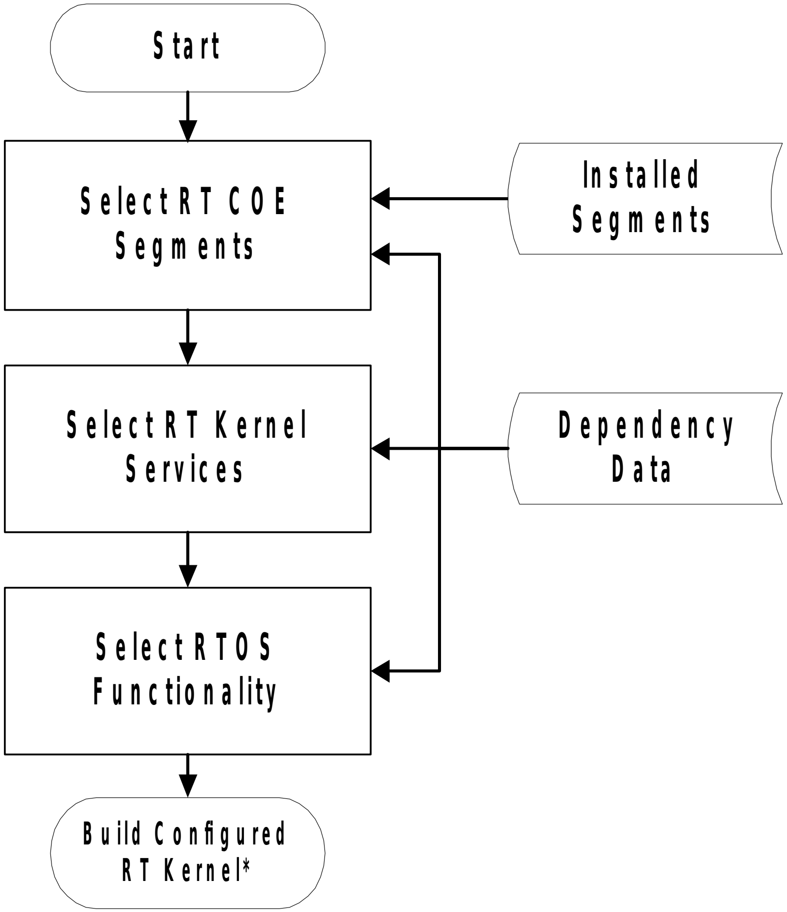


*Actual OS configuration depends on packaging options provided by RTOS vendor

RT Systems Are NOT One Size Fits All

RT DII COE Accomplishments
RT Kernel Configuration

- **Integrator specifies list of segments (required capabilities)**
- **Each segment requires:**
  - **Other segments**
  - **RT Kernel Services**
  - **POSIX.13 API's**
- **Each RT Kernel Service requires:**
  - **Other RT Kernel Services**
  - **POSIX.13 API's**



The Process to Build RT C2 System Using RT DII C

What do C2 System SPOs Do Now?

- SPD Challenge
  - Determine Need for RT Techniques
    - Priority, Preemption, Predictability
  - If YES,
    - Identify Common Functions Among Your C2 Node Partners in Accomplishing Your Mission
    - Provide C2 Requirements to RT TWG
    - Advocate Common Capabilities Into DII COE via RT IPT

RT DII COE: Path to C2 Interoperability

Conclusion

- **C2 Spectrum Being Defined**
- **RT Characteristics to Be Aware: Priority, Preemption, Predictability, Determinism**
- **Make DII COE Support Fixed Priority Scheduling**
- **SPD Challenges: RT and Common Functions**
- **RT DII COE Effort Is Making Progress**
  - **Become Part of the Team!**

RT DII COE a Reality: Oct 2000
RTOS, Selectable RT Kernel Services, RT CORBA